Comet Missions in NASA's New Millennium Program

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NASA's New Millennium Program (NMP) is designed to develop, test, and flight validate new, advanced technologies for planetary and Earth exploration missions, using a series of low cost spacecraft. Such new technologies include solar-electric propulsion, inflatable-rigidizable structures, autonomous navigation and maneuvers, advanced avionics with low mass and low power requirements, and advanced sensors and concepts for science instruments. The NMP program is administered for NASA by the Jet Propulsion Laboratory.

Two of NMP's currently identified interplanetary missions include encounters with comets. The first is the Deep Space 1 mission which will launch in July, 1998 and which will fly by asteroid 3352 McAuliffe, Mars, and periodic Comet West-Kohoutek-Ikemura. The encounter with P/WKI will be in June, 2000 and will be at a distance of $\sim$500 km from the nucleus and a flyby velocity of $\sim$15 km s^{-1}. The flyby is at a heliocentric distance of 1.6 AU, close to the perihelion of the comet. The DS-1 payload includes MICAS, a multispectral imager and spectroscope with both UV and near-IR capabilities, and PEPE, a plasma electron and ion spectrometer. MICAS will image the cometary coma and nucleus on approach and as the spacecraft recedes from the nucleus, while PEPE will measure the interaction of cometary ions with the solar wind.

The second NMP comet mission is Deep Space 4/Champollion which will be launched in April, 2003. DS-4/Champollion is a joint project with CNES, the French space agency. DS-4/Champollion will rendezvous with and orbit periodic Comet Tempel 1 in December, 2005, and will deploy a 120 kg lander to the nucleus surface in April, 2006. The Champollion lander instruments include: CHARGE, a gas chromatograph/mass spectrometer; CIVA, a set of 6 panoramic cameras, 3 with stereo capability; CIRCLE, a set of 3 near-field cameras plus a microscope with a built-in near-infrared spectrometer; CPPP, a pair of probes to measure the physical properties of the nucleus surface; and SATM, a drill for obtaining cometary samples at depths up to 1 meter. In addition DS-4/Champollion will likely carry a high resolution CCD camera for navigation and for mapping the nucleus surface from orbit, a contamination monitor/dust counter for evaluating the cometary coma environment, and a gamma-ray/neutron spectrometer on the lander to perform bulk elemental compositional measurements of the near-surface cometary materials.

Surface operations with the lander are expected to last 3 days, during which the landing site will be repeatedly photographed and multiple cometary samples will be collected and analyzed by the onboard instruments. At the end of the 3 days, the lander will collect three 15-cc samples from various depths below the nucleus surface and place them in hermetically sealed canisters. The upper half of the lander will then take off from the surface, rendezvous with the carrier vehicle in orbit, and transfer the sample canisters to the carrier. The carrier will then begin a 4.1 year journey back to Earth, arriving in May, 2010. The sample canisters will be kept at cryogenic temperatures during the cruise period. Upon arrival, the carrier vehicle will deploy a ballistic re-entry vehicle containing the sample canisters, for recovery on Earth. Detailed analyses of the cometary samples will be conducted in terrestrial laboratories.